BIOS

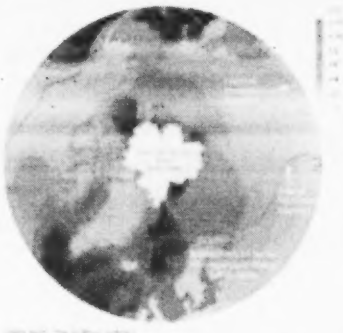
Alberta Society of Professional Biologists • 2004 Winter

Volume 19 • Number 4

ARCTIC CLIMATE IMPACTS

The northern polar region consists of a vast ocean surrounded by land. The most striking features are the snow and ice that cover much of the arctic land and sea surface.

A wide expanse of treeless plains or tundra lies between the ocean and the boreal forests that cover much of the two facing continents. The arctic lands and seas are home to an array of plants, animals and people that survive in some of the most extreme conditions on the planet. The short growing season and smaller variety of living things compared to temperate regions combined with a highly variable climate create a vulnerability.



The increasing rapid rate of recent climate change poses new challenges as average Arctic temperature has risen at almost twice the rate as the rest of the world in the past few decades. Over the next 100 years, climate change is expected to contribute to major physical, ecological, social and economic change. Changes in arctic climate will also affect the rest of the world through rising sea levels.

The Arctic Council, a high level intergovernmental forum comprised of the eight arctic nations, provides a mechanism to address common concerns and challenges faced by arctic people and governments. The rapid changes occurring in the arctic prompted the Arctic Council to call for an assessment of the impacts of climate change. In late 2004, the Arctic Council released a report entitled **"Impacts of a Warming Climate: Arctic Climate Impact Assessment"** (Cambridge University Press, 2004).

The Arctic Climate Impact Assessment (ACIA) includes 10 key findings related to climate changes and impacts. The key findings include:

1. Arctic climate is now warming rapidly and much larger changes are projected.
2. Arctic warming and its consequences have worldwide implications.
3. Arctic vegetation zones are very likely to shift, causing wide-ranging impacts.
4. Animal species' diversity, ranges, and distribution will change.
5. Many coastal communities and facilities face increasing exposure to storms.
6. Reduced sea ice is very likely to increase marine transport and access to resources.
7. Thawing ground will disrupt transportation, buildings, and other infrastructure.
8. Indigenous communities are facing major economic and cultural impacts.
9. Elevated unltraviolet radiation levels will affect people, plants, and animals.
10. Multiple influences interact to cause impacts to people and ecosystems.

A comprehensive science report (not online) was the basis

continued on page 7

IN THIS ISSUE

Arctic Climate Impacts 1
Member News 2
ASPB Mentor Program 3
Bios Bits 4
Bios Bits 5
Sustainable Forest Management Research 6
Arctic Climate Impacts cont'd 7
Arctic Climate Impacts concl'd 8

Alberta Society of Professional Biologists
P.O. Box 21104
Edmonton, Alberta
T6R 2V4
Tel: (780) 434-5765
Fax: (780) 413-0076
E-mail: pbiol@aspb.ab.ca

http://www.aspb.ab.ca

President
Robert Dallas (403) 735-2245
President Elect
Doug Collister (403) 246-2697
Past President
Teresa de Grosbois (403) 299-2778
Secretary
Maire Luoma (403) 716-8135
Treasurer
Gary Ash (780) 483-3499
Director
Steve Morck (403) 547-2049
Director
Garry Hornbeck (403) 281-3782
Director
Henry Epp (403) 201-2583
Director
Christine Brown (403) 297-8840
Director
Carol Engstrom (403) 298-6175
Public Member
Stuart Ross (403) 777-0111
Registrar
Carl Warner (403) 569-6591
Discipline Committee
Brian Bietz (403) 259-6571
Practice Review Committee
Don McCabe (403) 297-5671

Executive Director/Professional Liaison
Robin Leech (780) 452-1311
Professional Development (Calgary)
Carol Engstrom (403) 298-6175
Professional Development (Edmonton)
Rick Zolkiewski (780) 413-6079
Communications
Terry Antoniuk (403) 266-6363
Webmaster
Jim Case (403) 681-4447
Office Administrator
Jill Lane (780) 434-5765

BIOS is written for the enjoyment of the members of the Alberta Society of Professional Biologists and those interested in the field of professional biology. Articles or comments are welcomed and should be communicated to the ASPB Office. Editing and layout by Gavin More.

WELCOME NEW MEMBERS

Regular Member:

Lisa Bridges, Nadia Contant, Michael Maximchuk, Laura McCreanor, Christopher Teichreb, Eliot Terry

Biologist in Training:

Charles Brassard, Michael Bartlett, Corinne Johnson, Lisa Lowther, Colleen Simpson, Shaun Toner

Student Member:

Carl Zimmer

Membership Update

ASPB membership as of December 31, 2004: **Total 568**

Regular	470	Biologist in Training	60
Honorary	7	Temporary Withdrawn	14
Student	9	Public Member	1
Associated	7		

Calgary Youth Science Fair

Interested in helping to judge the 44rd annual Calgary Youth Science Fair on Friday March 18, 2005 from 7:15 AM to Noon? If so, please register online at http://www.cysf.org/checklist_judge.htm. 350 judges are needed for elementary projects (grades 5, 6), and 200 judges for secondary projects (grades 7 - 12).

Three events will help prepare you to be one of our 550 judges to judge over 1000 students:

March 8, 2005, 7 to 9 PM: Judges' Training Seminar - Although not required, this session is highly recommended for first time judges. This year's seminar will take place in the Western Canada High School amphitheatre.

March 16, 2005, 7 to 9 PM: Social Preview Night - Offered to all judges. It allows judges to preview the projects with no students present, and meet with other judges in a social setting. Snacks and beverages are provided. This will take place in the downstairs exhibition hall of the Big Four Building at Stampede Park.

March 18, 2005, 7:15 AM to Noon: Judging - A continental breakfast, juice and coffee will be provided. All Judges are expected to arrive by 7:15 a.m., and will be finished by about noon.

For more information, please look at: www.cysf.org.

ASPB Mentor Program

The Board would like to express a thank you to the following people who have volunteered to be a Mentor in the Mentorship Program. They are: Marc d'Entremont, Carol Engstrom, Todd Han, Suzanne Hawkes-Gill, Alan Kennedy, Sheila Leggett, Ricardo Moreno, David Reid, Chris Spytz, and James Wuite.

Of course, we are seeking more mentors and encourage other professional members to get involved. The following provides some useful information the program.

Why is ASPB involved in mentoring?

The Society recognized certain difficulties that younger biologists have fulfilling the requirements for professional membership. Biologists-in-Training, in particular, have acquired technical skills in their fields during university but usually find they need training in soft skills once they enter the workplace. Few companies offer mentoring programs. Therefore, the Society has initiated the mentoring program for the professional benefit of both experienced members and new biologists.

Who are the intended candidates for the program?

In regard to being a mentor, the program will appeal to many professional members who have an interest in assisting those who are less experienced.

In regard to being a protégé, the program will be of great interest to professional members who are just beginning their career and have also expressed an interest in being mentored. Therefore this program will be of greatest interest to Biologists-in-Training.

Experienced professional members, who may or may not also be mentors, and are entering a new field/company might also be interested in engaging a mentor.

BENEFITS OF BECOMING A MENTOR

- Refined interpersonal skills
- Enhanced self-esteem
- Pride in helping others
- Enhanced status in your organization
- Increased awareness of the talent pool available, and
- Mentoring is fun

CHARACTERISTICS OF A MENTOR

- Strong interpersonal skills
- Organizational knowledge
- Good supervisory skills
- Technical competence
- Willingness to be responsible for someone else
- Patience, and
- Willingness to take risks

BENEFITS OF BEING A PROTEGE

- Enhanced soft skills required in the workplace, e.g. teamwork, negotiating skills
- Becoming more goal-directed in your career development
- Increased self-confidence
- More accurate self-assessment of your strengths and weaknesses
- Increased knowledge of how organizations function, and
- Enhanced work performance and success with potential for promotion

CHARACTERISTICS OF A PROTEGE

- Willingness to learn and improve skills
- Strong belief in confidentiality
- Ability and willingness to listen actively
- Willingness and ability to self-evaluate
- Self-confidence, and
- Open to feedback

How does the mentoring program work?

There is a form (for both mentors and protégés) that has been developed and posted on the ASPB website that asks questions about your areas of expertise, geographic location and your communication style.

After you have completed the application form, you will be asked from time to time if you will be willing to mentor a specific individual. The choice is yours. If you find that you are going to be unavailable for a certain period due to workload, you can update your file to indicate that you are not available.

Similarly, protégés seeking a mentor will be paired with the most suitable mentor available at that time. The program is voluntary and you can develop the most appropriate arrangements with your mentor. You can also agree to terminate the mentor arrangement at any time.

Contact either Christine Brown at 403-297-8840 or christine.brown@gov.ab.ca or Carol Engstrom at 403-298-6175 or carol.engstrom@huskyenergy.ca for more information about the program.

Carol Engstrom, P. Biol.

Bios Bits

Court Cases

In November 2004 the Supreme Court of Canada reached a decision in the case of Taku River Tlingit First Nation v. British Columbia (Project Assessment Director). The Court found that the Crown did have a duty to consult meaningfully with and accommodate First Nations before making decisions on projects that may affect as yet unproven aboriginal rights and title claims. However; the Court also found that the Crown had met that duty in this case, with Taku River Tlingit First Nation being appropriately consulted and included in the EA process for the project. The Court noted that meaningful consultation does not require reaching agreement, but rather must balance the Aboriginal concerns with competing societal concerns.

In a related court case, Haida Nation v. British Columbia (Minister of Forests), the Court found that the Crown had not met its duty for consultation in this case (i.e. a tree farming license transfer). However, the Court found that Weyerhaeuser, the company that had received the license, did not share responsibility for ensuring proper consultation. Therefore, the responsibility for consultation does not lie with the proponent, but with the government assessors.

The Taku River Tilingit First Nation v. BC decision can be found at:www.lexum.umontreal.ca/csc-scc/en/rec/html/2004scc074.wpd.html and the Haida Nation v. BC decision at:www.lexum.umontreal.ca/csc-scc/en/rec/html/2004scc073.wpd.html

Impact of NWT Gas Development

A series of maps released by the Canadian Arctic Resources Committee (CARC) shows predictions of the potential footprint and possible future impacts of developments associated with the Mackenzie Gas Project and other projects in the northern portion of the Northwest Territories.

CARC applied modelling techniques to a gas study submitted by the pipeline proponents' to show the extent and impact of the project on the landscape. The results show a complex series of seismic lines, wells, and feeder lines carving through thousands of sq km of land. The areas around the Mackenzie Delta/Beaufort Sea, and Colville Lake are particularly affected. A final map also shows the possible impact on large mammals such as caribou.

CARC filed its project with the Joint Review Panel. The map series is available on CARC's website, www.carc.org. CARC is also producing posters showing a selection of the maps, to be distributed to communities along the proposed pipeline route.

DFO Signs Fish Habitat Agreement

In October 2004, the Honourable Geoff Regan, Minister of Fisheries and Oceans Canada (DFO) and Mr. Pierre Alvarez, President of the Canadian Association of Petroleum Producers (CAPP) speaking on behalf of the members of the National Resource Industry Associations (NRIA), announced the signing of a partnership agreement that will result in better protection of fish habitat and more efficient services to Canadians. The NRIA include: the Canadian Association of Petroleum Producers, the Canadian Electricity Association, the Canadian Energy Pipeline Association, the Canadian Gas Association, the Forest Products Association of Canada, the Mining Association of Canada and the Prospectors and Developers Association of Canada.

"DFO is modernizing its environmental processes and making an important contribution to the Government of Canada's smart regulations strategy," said Minister Regan. "This includes streamlining regulatory processes, enhancing partnerships and clarifying the rules for dealing with developments impacting fish habitat."

"Industry gains greater certainty, efficiency and clear operating rules in complying with the habitat provisions of the Fisheries Act, and Canadians are assured of better protection of fish habitat," said CAPP President Pierre Alvarez.

A steering committee will develop and implementing work plans to achieve common objectives and to report on results. This year, the focus of the work is on developing clear guidelines and adjusting best management practices to improve the efficiency and effectiveness of fish habitat regulatory processes.

Minister Regan noted that a key element in DFO's environmental process modernization plan, and in the success of this agreement, is to establish fish habitat cooperation agreements with provinces and territories. This will reduce duplication of effort and project processing times. These agreements are also well advanced.

The agreement is available on the DFO website at: www.dfo-mpo.gc.ca/canwaters-eauxcan/habitat/partners-partenaires/nria/nria_e.asp.

Edmonton Science Outreach

The Edmonton Science Outreach Network is a non-profit organization that promotes science education. Volunteer scientists, technologists, engineers, mathematicians and trades people visit school classrooms, grades 1 - 12, to give hands-on presentations on science topics related to the curriculum. Topics range from 'Hot and Cold Temperatures (Gr 2) to Wetlands (Gr 6) to Mechanical

Bios Bits

Systems (Gr 8). With such a diversity of topics, volunteers are needed from many fields. If you wish to volunteer to help students learn about science and expose them to potential careers, contact Michael Caley, Executive Director at 780-448-0055 or esons@telus.net.

Emerald Awards - 2005 Nominations

Nominations for the Emerald Awards, held annually in Alberta to recognize environmental excellence by individuals or organizations, are being accepted until 28 February.

Visit www.emeraldawards.com or contact the Emerald Awards office for a nomination form. For more information email:bvandersteen@trevose.com.

Species at Risk Added

Seventy-three new species were added to Schedule 1, the list of species protected under the Species at Risk Act (SARA) on January 21, 2005. This is the first group of species added to SARA, since the Act was proclaimed in 2003 and bring the number of species that are protected under SARA to 306. The Canada Gazette, Part II, January 26 (http://canadagazette.gc.ca/partII/2005/20050126/pdf/g2-13902.pdf) and SARA Registry lists the additions.

The additions include 4 Extirpated species, 31 Endangered species, 18 Threatened, and 20 species of Special Concern. Of the 73 species added, 60 are terrestrial species for which the Environment Canada is responsible and 13 are aquatic species for which the Fisheries and Oceans Canada has primary responsibility. Environment Canada also has responsibility for 4 of the 13 aquatic species as they occur within lands administered by the Parks Canada Agency.

This Order removes 16 species from Schedule 2 and 27 species from Schedule 3 of SARA as these species have now been added to Schedule 1. It also corrects spelling, typographical and taxonomic errors for 55 species previously listed in Schedule 1. As a result of this amendment, the names of species in Schedule 1 have been updated to correspond to the names currently used by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

The decision to add these species to the list is the result of a thorough, transparent process which took into account scientific assessments, traditional Aboriginal knowledge, public consultations and public comment.

Listed species will benefit from the implementation of recovery strategies, action plans and management plans. Proposed recovery strategies, developed in consultation or cooperation with stakeholders, Aboriginal peoples and the public, must be included in the Public Registry within one year of a species being listed as endangered and within two years for a species listed as threatened or extirpated. Proposed management plans for species of special concern must be prepared and posted on the Public Registry within three years of the species being listed.

For future projects that affect a listed species and trigger a federal environmental assessment, SARA requires notification of the competent Minister. The person responsible for ensuring such environmental assessments are conducted must also identify any adverse effects of the project on the listed species or its critical habitat and ensure that measures are taken to avoid or lessen those effects and to monitor them.

Originally, 79 species were under consideration for inclusion under SARA. The polar bear, the Northwestern population of grizzly bear and the Western population of wolverine will not be added to the list at this time, in order to provide an opportunity for Environment Canada to consult further with the Nunavut Wildlife Management Board on concerns that they have raised. These consultations are expected to be concluded by the end of May.

Cultus Lake and Sakinaw Lake sockeye salmon will also not be added to the list. However, comprehensive recovery plans for these species will be completed and Fisheries and Oceans Canada will continue to pursue its action plan to protect and rebuild the Cultus and Sakinaw Lake sockeye populations.

The assessment of the speckled dace will be returned to the COSEWIC for further information and consideration.

To view other relevant background documents visit the Species at Risk web site (www.speciesatrisk.gc.ca) or the SARA Public Registry site (www.sararegistry.gc.ca).

Species at Risk Web Mapping

The Species at Risk Web Mapping Application allows users to identify endangered, threatened, and special concern species that occur in geographic areas of interest. Currently only SARA Schedule 1 species are available.

In general, species occurrences were developed for plant species and relatively sedentary animals and animals which are confined to a well defined geographic area, whereas species ranges were developed for non-sedentary animals. Occurrences have been generalized for species considered to be sensitive for conservation or other reasons so not to give their exact location. The distribution data presented on this web site is based on limited available information.

To access the Species at Risk Web Mapping Application, go to www.speciesatrisk.gc.ca/map/default_e.cfm.

Sustainable Forest Management Research

There are few biologists who would say they have not heard the term "sustainable forest management", otherwise known as "SFM". Conversely though, few would have an easy time of providing an adequate definition of SFM. Despite its simple premise, sustainable forest management is a difficult concept and its implementation is a difficult task.

SFM is not a radical departure from traditional forestry, but rather an evolution of it. SFM can be thought of as the broadening of a sustained yield approach to forestry to include a continuous supply of multiple forest values (ecological, social and economic) in addition to timber. It is this broadening of values, along with the concept of intergenerational equity (i.e., the next generation has continued access to forest conditions and values that have not been degenerated), that provides a formal definition and goal of sustainable forest management: "...to maintain and enhance the long-term health of our forest ecosystems, for the benefit of all living things both nationally and globally, while providing environmental, economic, social, and cultural opportunities for the benefit of present and future generations." Simply put, SFM is fundamentally about passing on forests to the next generation that have at least the same ecological, economic, and social value they have now.

The principles of sustainable development, as they relate to SFM, were enshrined in national policy in March 1992 as part of Canada's National Forest Strategy (nfsc.forest.ca/strategies/strategy5.html) by the Canadian Council of Forest Ministers (CCFM). In 1995, the CCFM subsequently released a framework for sustainable forest management in the form of 6 criteria and a wide variety of indicators (www.ccfm.org/ci/framain_e.html). This framework has since become the basis of evaluating and reporting on the success of achieving SFM in Canada, and provides SFM leadership around the world.

The Role of the Sustainable Forest Management Network

The Sustainable Forest Management Network, or the "SFMN", is a national-level forest research organization hosted by the University of Alberta and governed by a Board of Director's made up of partner representatives from across Canada. The SFMN was created in 1995 as part of Canada's Network of Centres of Excellence program, and in response to a public desire for SFM. The SFMN's mandate is to deliver an internationally-recognized, partner-collaborative, interdisciplinary and collaborative research program that performs university-based research in support of SFM. Research funding is allocated to researchers across Canada through an annual competitive proposal process. Additional objectives include training highly qualified personnel (graduate students and resource management professionals) and developing innovative methods of knowledge exchange and technology transfer in support of SFM-based policy and approaches to forest management planning and practices.

The SFMN is a partnership of 27 funding partners (federal and provincial governments and territories, the forest industry, Aboriginal organizations and First Nations, and non-government organizations) and 35 institutional partners (universities) across Canada - all supporting the broad objective of delivering high-quality SFM research to SFMN partners and all Canadians. Alberta is heavily involved in SFMN activities with institutional partners including the Universities of Alberta and Calgary. Funding partners include Alberta-Pacific Forest Industries Inc., Canadian Forest Products Ltd., Daishowa-Marubeni International Ltd., Millar Western Forest Products Ltd., Tolko Industries Ltd., and the Province of Alberta (Sustainable Resource Development). Ducks Unlimited Canada, the Little Red River Cree Nation, the Heart Lake First Nation, Parks Canada, and Environment Canada round out the diverse list of funding partners in Alberta.

Delivering the SFMN Research Findings

The SFMN uses two primary means of delivering and extending research findings: (1) research documents are widely available for free download via the internet, and (2) through extension activities and documents created and coordinated by the Network's Knowledge Exchange and Technology Extension program, otherwise known as "KETE". Not mutually exclusive, KETE coordinates the creation of extension documents which are in turn made available on the SFMN website along with other research products created directly by SFMN researchers. KETE's primary mandate is the synthesis, integration and extension of SFM Network research results to promote the development and implementation of SFM policy and practices. This is accomplished primarily through the creation of a series of documents targeted at forest managers and practitioners, and workshops intended to deliver research results and provide opportunities for researcher-practitioner interaction.

For more information on the SFMN, the research program, or to access SFMN research products contact the Sustainable Forest Management Network (tel: 780-492-6659) or visit the SFMN website (http://sfm-1.biology.ualberta.ca). Most SFMN research products are available for free download from the SFMN website.

By Robert G. D'Eon, Margaret Donnelly, and Cynthia Kaufmann

Rob D'Eon is an ecological consultant and science writer based in Nelson, BC. Margaret Donnelly is an ecological consultant based in Weymouth, NS. and is currently the SFMN's KETE program manager. Cynthia Kaufmann is a forester and extension coordinator with the SFMN in Edmonton, AB.

Arctic Climate Impacts cont'd

for this summary report (see the appendices for the chapters and contributors). Each of the key findings is discussed through the presentation of a highly illustrated overview of the supporting evidence.

Warming in the Arctic is causing changes. The ACIA explores these trends in greater detail in the report and in the full science report. The issues and challenges described include:

Rising Temperatures - Winter increases in Western Canada have been around 3-4^{o}C over the past half century.

Rising River Flows - River discharge has increased and peak spring river flows are occurring earlier.

Declining Snow Cover - Extent of snow cover has declined ~10% over the past 30 years. Additional decreases of 10 - 20% by the 2070s are projected.

Increasing Precipitation - Arctic precipitation has increased ~8% with much as rain, with the largest increases in autumn and winter.

Thawing Permafrost - Permafrost has warmed by up to 2^{o}C and the depth of the thaw layer is increasing. The southern limit of permafrost is projected to shift northward by several hundred km during this century.

Diminishing Lake and River Ice - Later freeze-up and earlier break-up have reduced the ice season by 1 to 3 weeks in some areas.

Melting Glaciers - Glaciers throughout the Arctic are melting with a rapid retreat of Alaskan glaciers representing ~half of the loss of mass of glaciers worldwide.

Melting Greenland Ice Sheet - The area experiencing some melting has increased about 16% from 1979 to 2002.

Retreating Summer Sea Ice - The average extent of sea-ice cover in summer has declined by 15 - 20% over the past 30 years. This decline is expected to accelerate. A near total loss is projected for late this century.

Rising Sea Level - Global and arctic sea level has risen 10 - 20 cm in the past 100 years. An additional half m rise is projected to occur this century.

Ocean Salinity Change - Reduced salinity and density has been observed in the North Atlantic Ocean. It could cause changes in ocean circulation patterns that strongly affect regional climate.

Wetland Changes - Permafrost thawing will cause lakes and wetlands to drain in some areas while creating new wetlands in other areas.

Vegetation Shifts - Vegetation zones are projected to shift northward with forests encroaching on tundra and tundra encroaching on polar deserts.

Increasing Fires and Insects - Forest fires, insect infestations and other disturbances are projected to increase in frequency and intensity.

Northward Species Shifts - Many plant and animal species are projected to shift their ranges northward. Some arctic species are likely to suffer major declines.

Marine Species at Risk - Marine species dependent on sea-ice, including polar bears, ice-living seals and some marine birds are likely to decline with some species facing extinction.

Land Species at Risk - Species specifically adapted to the arctic climate are at risk including many species of mosses and lichens, lemmings, arctic fox and snowy owl.

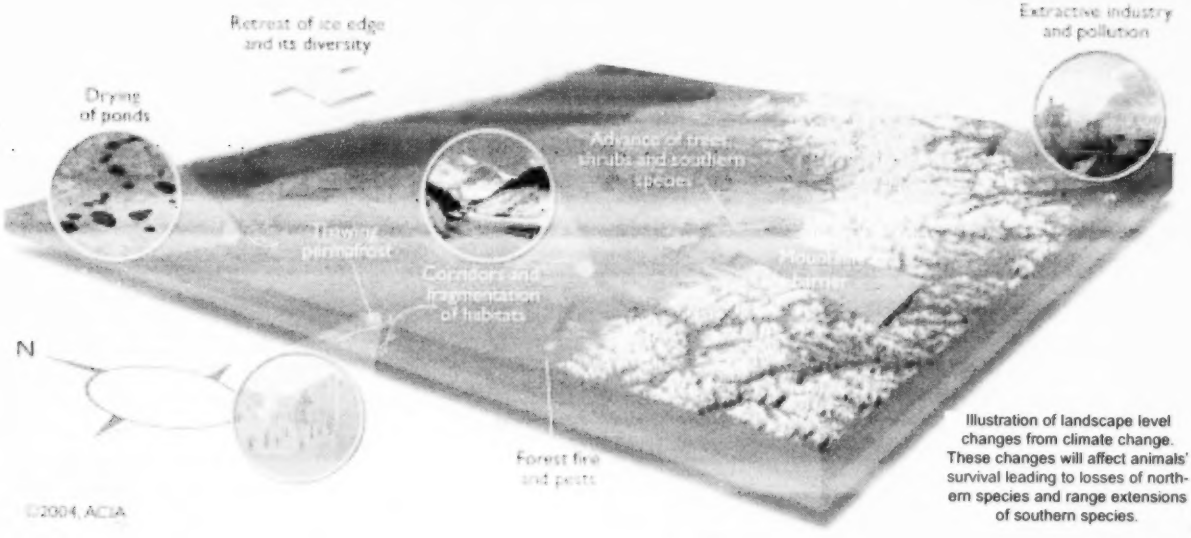


Illustration of landscape level changes from climate change. These changes will affect animals' survival leading to losses of northern species and range extensions of southern species.

Arctic Climate Impacts

UV Impacts - Increased ultraviolet radiation reaching the earth's surface as a result of stratospheric ozone depletion will impact ecosystems on land and water.

Old-growth Forest Loss - The increase in fires and insect caused tree death could reduce old-growth ecosystems and related species of mosses, lichens, insects and birds.

Carbon Cycle Changes - Replacement of arctic vegetation with southern species is likely to increase carbon dioxide uptake. However, methane emissions, from warming wetlands and thawing permafrost, are likely to increase.

Loss of Hunting Culture - For Inuit, warming is likely to disrupt or even destroy their hunting and food-sharing culture.

Declining Food Security - Access to traditional foods including seal, polar bear, caribou, and some fish and bird species is likely to be seriously impaired.

Human Health Concerns - Human health concerns include increased accident rates due to environmental changes such as sea-ice thinning, and health problems from adverse impacts on sanitation infrastructure due to thawing permafrost.

Wildlife Herd Impacts - Caribou and reindeer herds will face a variety of changes in their migration routes, calving grounds, and forage availability as snow and river ice conditions change.

Increasing Access to Resources - Marine access to arctic resources is likely to be enhanced by the reduction in sea ice.

Enhanced Marine Fisheries - Some major arctic marine fisheries including those for herring and cod, are likely to be more productive.

Disrupted Transport on Land - Northern communities that rely on frozen roadways to truck in supplies will be affected. Oil and gas extraction will increasingly be disrupted by the shrinking period during which ice roads and tundra are sufficiently frozen to allow operations.

Decline in Northern Freshwater Fisheries - Decreased abundance and local and global extinctions of arctic-adapted fish species are projected. Species threatened by a warming climate include Arctic char, broad whitefish and Arctic cisco.

Enhanced Agriculture and Forestry - Agricultural and forestry opportunities are likely to increase as potential areas for food and wood production expand due to a longer and warmer growing season and increasing precipitation.

The ACIA report concludes with a discussion of selected impacts on the environment, the economy and people's lives for each of the four sub-regional divisions. The western subregion of Alaska and Western Canadian Arctic has experienced the most dramatic warming. One projection suggests a threefold increase in the total area burned by forest fires per decade. Arctic biodiversity is highly concentrated in this subregion; over 70% of the rare arctic plants occur nowhere else. Threatened species in this subregion include the whooping crane and lesser white-fronted goose. Increases in the frequency and ferocity of storm surges have triggered increased coastal erosion that is threatening sveral villages along the coasts of the Bering and Beaufort Seas.

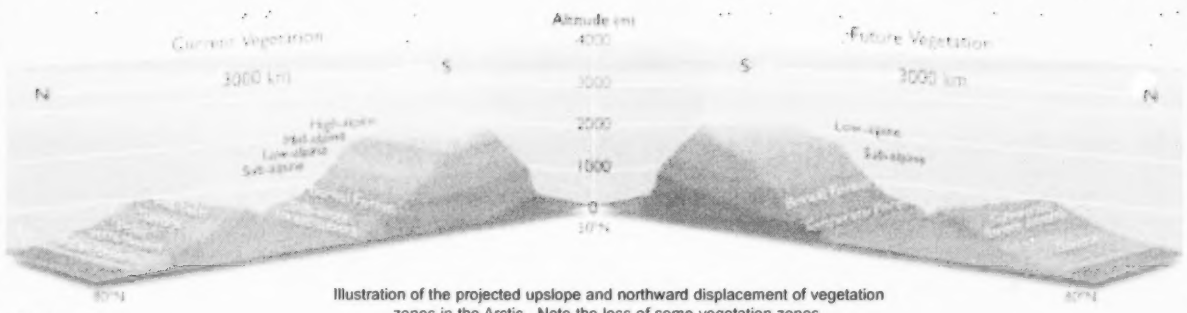


Illustration of the projected upslope and northward displacement of vegetation zones in the Arctic. Note the loss of some vegetation zones.

In the Central and Eastern Canadian Arctic subregion the thickness of fast ice is projected to decrease substantially and the northern retreat of sea ice during the summer is projected to increase from the current 150 - 200 km to 500 - 800 km this century. Should the Arctic Ocean remain ice-free in the summer for a number of consecutive years polar bears could be driven toward extinction. Significant areas of permafrost are at risk of thawing and many areas will experience widespread thermokarsting and increases in slope instability. Shrinking of arctic tundra extent is likely from a northward movement of treeline as much as 750 km in some areas. Climate change will affect the distribution and quality of animals and other resources on which the health and lifestyles of many northern communities are based.

Source: Extracted from **"Impacts of a Warming Climate: Arctic Climate Impact Assessment"** (Cambridge University Press, 2004). To download the ACIA summary report and selected graphics go to http://www.acia.uaf.edu